NREL-BA Team CARB

2014 Building Technologies Office Peer Review

CARB

Consortium for Advanced Residential Buildings

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Steven Winter Associates, Inc.

Project Summary

Timeline:

Start date: January 2013

Planned end date: January 2015

(BA Teams operate on a CY timeline though funded with FY funding, this review includes FY13 & FY14)

Key Milestones (general BA project milestones)

1. Project Planning and Go/No-Go; previous Q3 – Q4
2. Detailed Project Test Planning & Review; Q2
3. Project Execution and Ongoing Evaluation; Q2 - Q4
4. Reporting and Communication; Q1 subsequent

Budget:

FY13 DOE $: $7,200k for all 10 BA industry partnerships (average $720k per team excluding cost share)

FY14 DOE $: $8,135k for all 10 BA industry partnerships (average $814k per team excluding cost share)

Total future DOE $: TBD (program up for re-solicitation)

Target Market/Audience:

Residential building industry stakeholders - developers, builders, trade partners, architects, whole house contractors, utilities and other program developers with focus on “above code” market actors.

Key Partners:

BASF	BrightBuilt Home
Carrier	NEEP
AO Smith	CL&P & UI
Preferred Builders	NYSERDA
Eco Village	UC Davis WCEC

Project Goal:

Develop and demonstrate **market-ready** building solutions that improve the energy efficiency of new and existing homes, with increasing comfort, health, safety, and durability. Conduct research with manufacturing and building partners to verify performance of new equipment/technology and aid in the advancement of newer, better, more cost-effective options. When fully deployed, proven solutions would reduce building-related energy use by **30 percent and 25 percent, respectively, in new and existing residential building stock by 2020, and 50 percent and 40 percent by 2030.**

Purpose and Objectives

Problem Statement:

- Builders , homeowners , and contractors need hands-on guidance to integrate new, innovative technologies into their homes.
- The **perceived** risk and cost is high.
- Early adoption quality assurance is critical to success. We don't always know the integration issues until we get into the homes.

Target Market and Audience:

At the individual project level, we focus on the innovators and early adopters that want to distinguish themselves from their competition. At the program level, our audience is all residential building industry stakeholders.

Planned Contribution to Energy Efficiency:

BA program outputs **enable** 30% near-term and 50% long-term source energy savings in new and existing homes. BA teams develop and demonstrate marketable system packages that **reliably** achieve these savings targets. Successful demonstrations are documented and disseminated via technical reports, measure guidelines, the Solution Center, trade journal articles, conference presentations, webinars, and videos.

Approach

CARB Approach:

- Work directly with builders and building owners to implement advanced methods and products in their buildings.
- Measure and document the performance for dissemination to the broader audience.
- Provide assurances that making advances will do no harm.

CARB Distinction:

Steven Winter Associates , Inc. has successful business groups that provide consulting and certification services for ENERGY STAR, LEED-H, and Passive House – nearly 2000 units certified last year. Through these services, we become aware of the market concerns and challenges that need to be addressed. This client base serves as our primary source for test and demonstration homes and the CARB research results then feedback into the program requirements and specifications for broad impact.

Project Integration and Collaboration

Project Integration: We work directly with the new product manufacturers, the builder or homeowner, and the contractors. We utilize the building science industry to disseminate our results.

Partners, Subcontractors, and Collaborators:
Product Manufacturers - BASF, Carrier, ThermaStor, Munters, Energy Conservatory
Utilities/Programs – NEEP, NYSERDA, CL&P, EPA, VEIC, Passive House
Labs/Universities – ORNL, WCEC, WSU

Communications:
Conferences – ACEEE HWF, ACI, ASHRAE, Buildings XII, EEBA, NESEA, Passive House, local AIA and utility workshops
Trade Journals – Green Builder, JLC, Home Energy, EDU
Videos and Webinars – Challenge Home, NEHERS, BA
Expert Meetings – team collaboration and building science community

CARB SOW 2013 and 2014

- **High-R Wall Evaluation and Moisture Guideline**
- **Ventilation Guideline for Existing Homes**
- **Cold Climate ZERH Demonstration**
- **Zero Net Energy Ready Modular Homes**
- **Multifamily**
  - **MF Ventilation Best Practices Guide**
  - **Compartmentalization with an Aerosol-Based Sealing Process**
  - Envelope Leakage Predictions
  - Deep Energy Retrofit – Conway St.
  - Modest Energy Retrofit – Marcus Garvey

- Whole-House Dehumidifiers
- Solar Water Heating Evaluation
- Evaluation of Cold Climate ASHPs
- Validating DOE Challenge Home Energy Savings Claims
- Space Conditioning Impact of HPWHs
- Sealed Crawlspace Ventilation in Cold Climates
- Retrofitting a 1960s Split-Level Home
- Field monitoring of unvented attics for ORNL
- Low Load HVAC Needs Assessment

Moisture Performance of High-R Walls - Purpose and Objectives

Problem Statement:

- High-R walls (R-40 and above) see increased durability risks:
  Condensation, reduced drying potential, and prolonged periods of high moisture levels
- Gaining traction in the market due to programs like DOE Challenge Home and increasing code requirements
- 2012 IECC, Zone 6 and higher required to install exterior insulated sheathing or increase the depth of the wall cavity
- Field data are needed to validate models (WUFI) and design guidance (ASHRAE 160)
- Detailed guidelines and specific scopes of work are necessary to prevent assembly failures

Target Market and Audience:

- Building science community, architects , builders, and contractors.

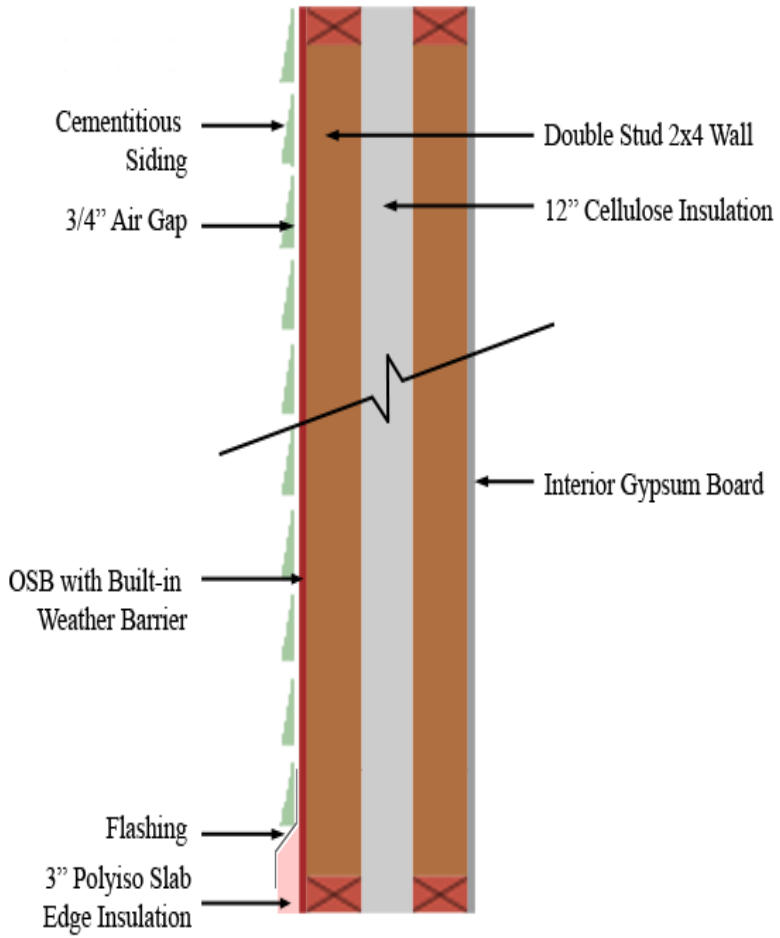
Planned Contribution to Energy Efficiency:

- Most cost-effective efficiency strategy - maximize insulation
- Durable, ≥ R40 walls are needed to achieve 50% Source Energy Savings in cold climates

Approach

CARB's focus is on walls **without** exterior insulating sheathing - primarily double-stud walls with cavity insulation only . Builders find these most similar to conventional framing practices requiring the least training and learning curve.

- Modeling w/ WUFI & THERM
- Field testing – moisture content of components at start of construction
- Long term monitoring – moisture levels, RH & temperature at various points in the walls
- Comparison of modeling & field data
- Evaluate against accepted failure criteria
- Develop guides based on modeling and monitoring



Project Sites

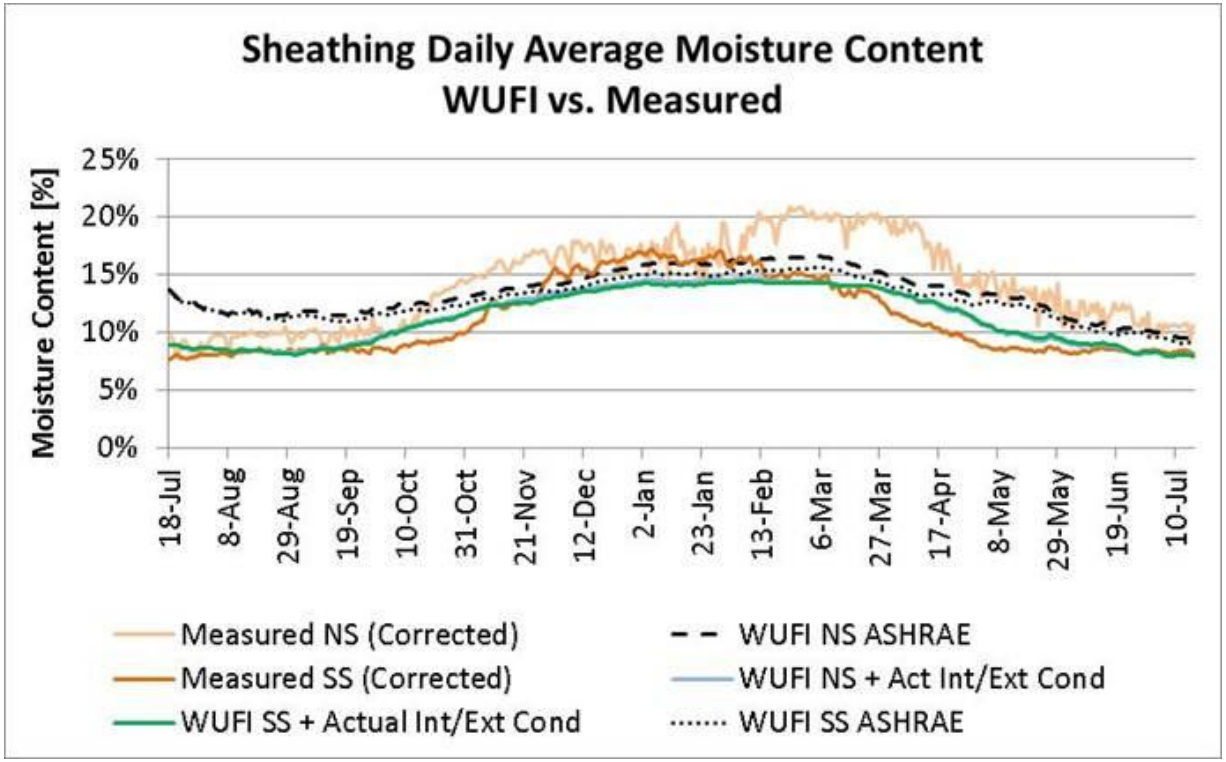
Wisdom Way (MA) 2010: 20 homes

Devens (MA) 2013: 12 homes

EcoVillage (NY) 2014: 26 homes

Progress and Accomplishments

- WUFI predictions are good
- Moisture management layer is crucial
- Revising failure criteria (ASHRAE 160)



- Procured NYSERDA funding to expand research to climate zone 6 and thicker walls

Project Integration and Collaboration

Project Integration:

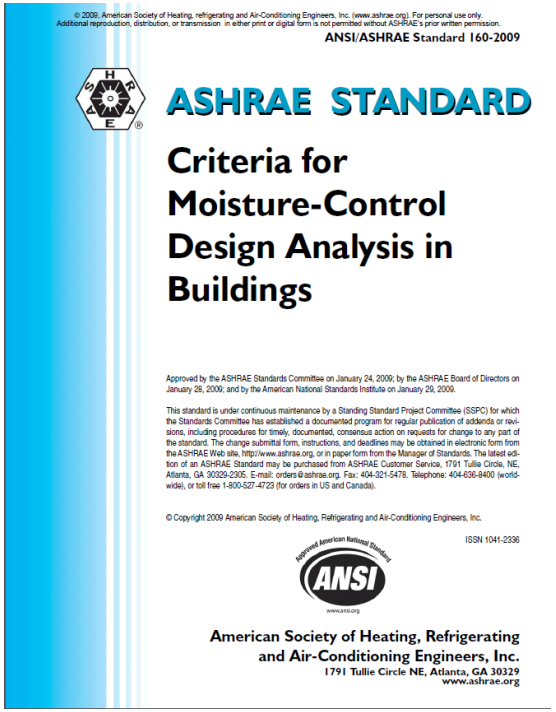
- Working directly with WUFI experts
- Member of the Standard 160 Committee

Partners, Subcontractors, and Collaborators: SPFA, NYSERDA, Other teams (BSC, NAHBRC, John Straube)

Communications:

Conferences –Passive House, EEBA, Buildings XII

Articles – Energy Design Update, Green Building Advisor



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Next Steps and Future Plans

- Develop a Measure Guideline for High-R Wall Assemblies without Exterior Insulating Sheathing (Zone 5)
- Continue to collect and analyze data from Climate Zone 6 project (NYSERDA funding)
- Presenting findings at a BSC Expert Meeting in May
- Research more wall assemblies in more cold climates
- Disseminate the findings via conference papers, presentations, and articles

New Construction Demonstration Homes - Purpose and Objectives

Problem Statement:

- Builders , homeowners , and contractors need hands-on guidance to integrate new, innovative technologies into their homes.
- The perceived risk of trying something unproven and cost is high.
- Early adoption quality assurance is critical to success. We don't always know the integration issues until we get into the homes.

Target Market and Audience:

Innovator and early adopter builders that want to distinguish themselves from their competition.

Planned Contribution to Energy Efficiency:

Successful demonstrations are documented and disseminated via technical reports, measure guidelines, case studies, the Solution Center, trade journal articles, conference presentations, webinars, and videos.

New Construction Test Homes: DOE Challenge Home

CARB/SWA worked with 3 of 19
DOE Challenge Home 2013
Housing Innovation Award winners

"Building science is a big part [of the design process], especially with new products that have come out. Everything needs to be compatible with each other. It starts by design and planning well before construction begins when you are building a home that is so airtight and energy-efficient."
(Source: Greenwich Post 2012)
Peter Fusaro, Preferred Builders Inc.

Ithaca Neighborhood Housing Services
11 townhomes

Progress and Accomplishments

First in 8-home Singer Village community

Discoveries: Complying with the water efficiency requirement of the DOE Challenge Home can be difficult without incorporating an on-demand recirculation pump.

Accomplishments:

Source Energy Savings: 29.6%

HERS Index: 45

From the builder perspective, the incremental cost to achieve this DOE Challenge Home was 5.5% more for the builder, while adding an estimated 8.2% of additional value to the home.

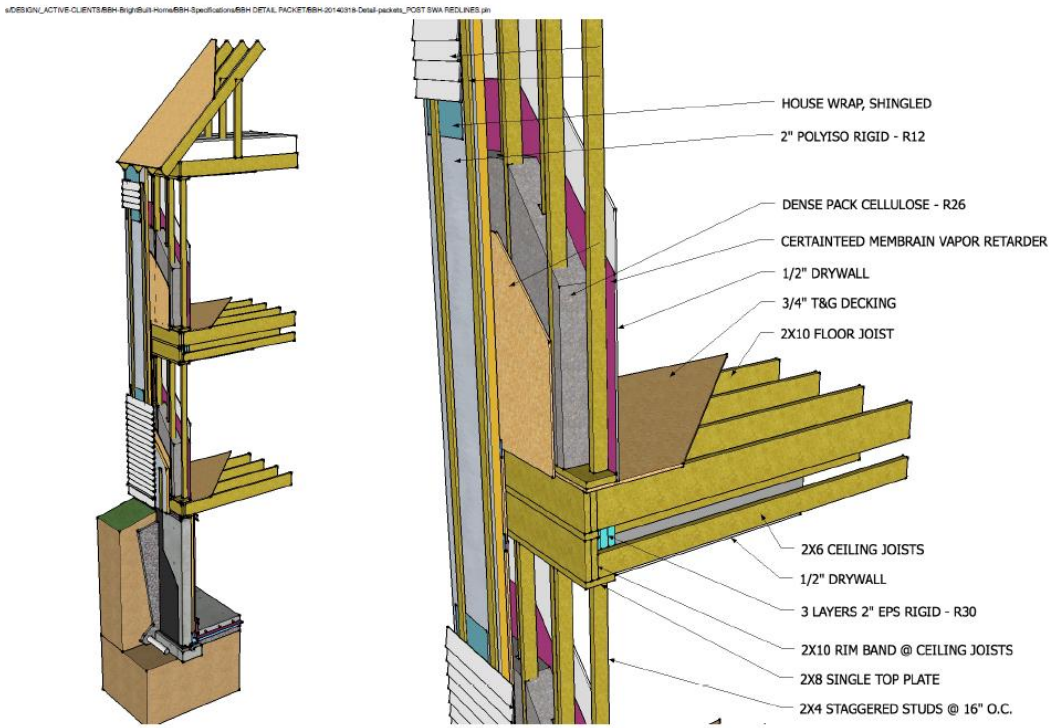
Awards: 2013 Connecticut Zero Energy Challenge Award winner

Communications: Worked with United Illuminating to create an informational video

Next Steps and Future Plans – BrightBuilt Homes

Document the Business Case for Modular Zero Energy Homes

- Meeting a market demand for attractively-priced Zero Energy Homes.
- Taking advantage of modular savings and quality control.
- 4 projects completed, 6 under way, 100-200 inquiries
- Since BBH launch (~1 year ago), 37% of Keiser Homes web traffic from BBH
- Optimizing factory-friendly envelope (cellulose in double-wall, 2” ext. foam)
- Simplifying site details
- Streamline/standardize HVAC



Ventilation Guideline for Existing Homes - Purpose and Objectives

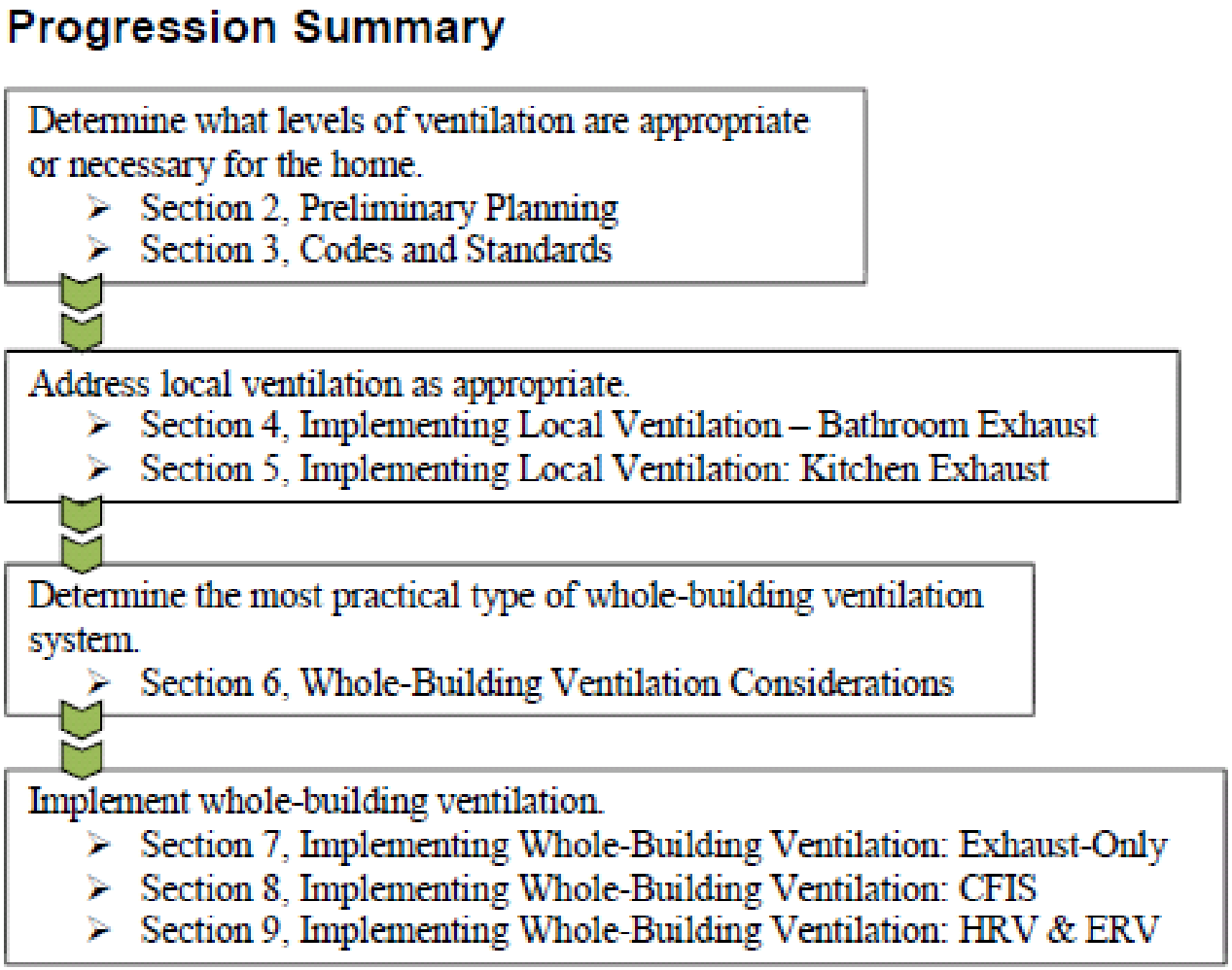
Problem Statement:
Choosing the “best” system is not always straightforward; selecting a system involves balancing performance, efficiency, cost, required maintenance, and several other factors. It is the intent of this document to assist contractors in making more informed decisions when selecting systems.

Target Market and Audience:
Decision makers and contractors implementing ventilation systems in homes.

Planned Contribution to Energy Efficiency:
With tighter building envelopes, a mechanical means of removing contaminants is critical for indoor environmental quality and building durability.

Approach

Review research findings and experiences of several teams and consolidate into a useful guide for the energy retrofit market.



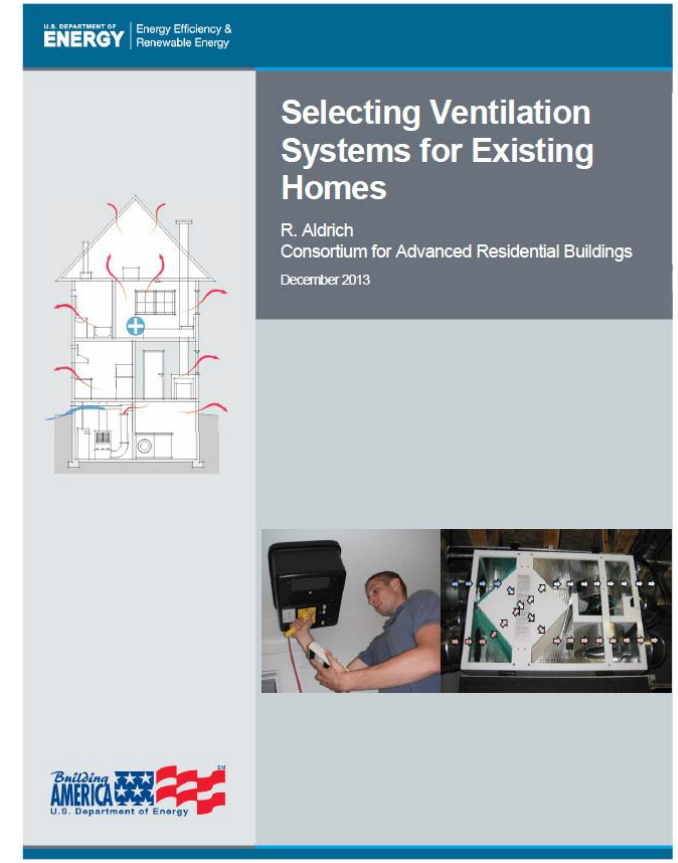
Progress and Accomplishments

Discoveries:
Achieving consensus in the building science community is not easy.

Accomplishments:
58-page comprehensive guide for local exhaust and whole-building ventilation published in February 2014 after extensive peer review.

Project Contribution to Energy Efficiency :
Critically important to IAQ and moisture control in homes implementing energy retrofits.

Awards/Recognition:
Submitted for a Top Innovation Award – Effective Guidance and Tools category.
Author has presented on the topic several times.



Purpose and Objectives - Multifamily Research

- Develop, demonstrate, and document energy efficiency opportunities for a market sector that provides housing for millions and accounts for 9% of residential site energy use
- 500,000 multifamily structures with 5 or more units in the U.S.
  - more than 15 million occupied rental units
  - another 2.6 million condo and coop (owned) units

>30% of 2013 housing starts were multifamily units (376,000 vs. 610,000 single-family permits)

85% of multifamily units were built before 1990

Multifamily Ventilation - Purpose and Objectives

Problem Statement:

- LEED for Homes and NYSERDA's Multifamily Performance Program went beyond ASHRAE 62.2 and require dedicated outdoor air to each unit.
- ENERGY STAR has not yet adopted this requirement and would greatly benefit from research that shows which outdoor air strategies should be permitted, prohibited, and which ones are the most effective in terms of performance and costs.

Target Market and Audience:

Multifamily efficiency programs.

Planned Contribution to Energy Efficiency:

With tighter building envelopes, a mechanical means of removing contaminants is critical for indoor environmental quality and building durability.

Approach

Evaluate Installed Performance of 4 Different Ventilation Strategies

Exhaust only

Exhaust + Corridor Supply

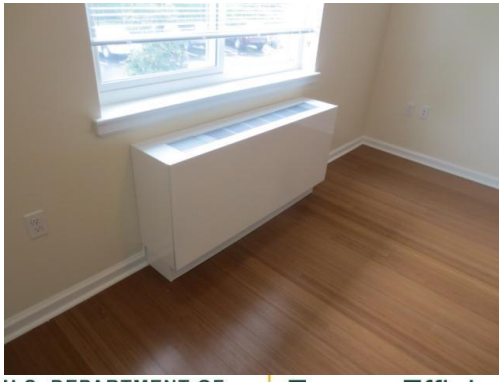
+

+

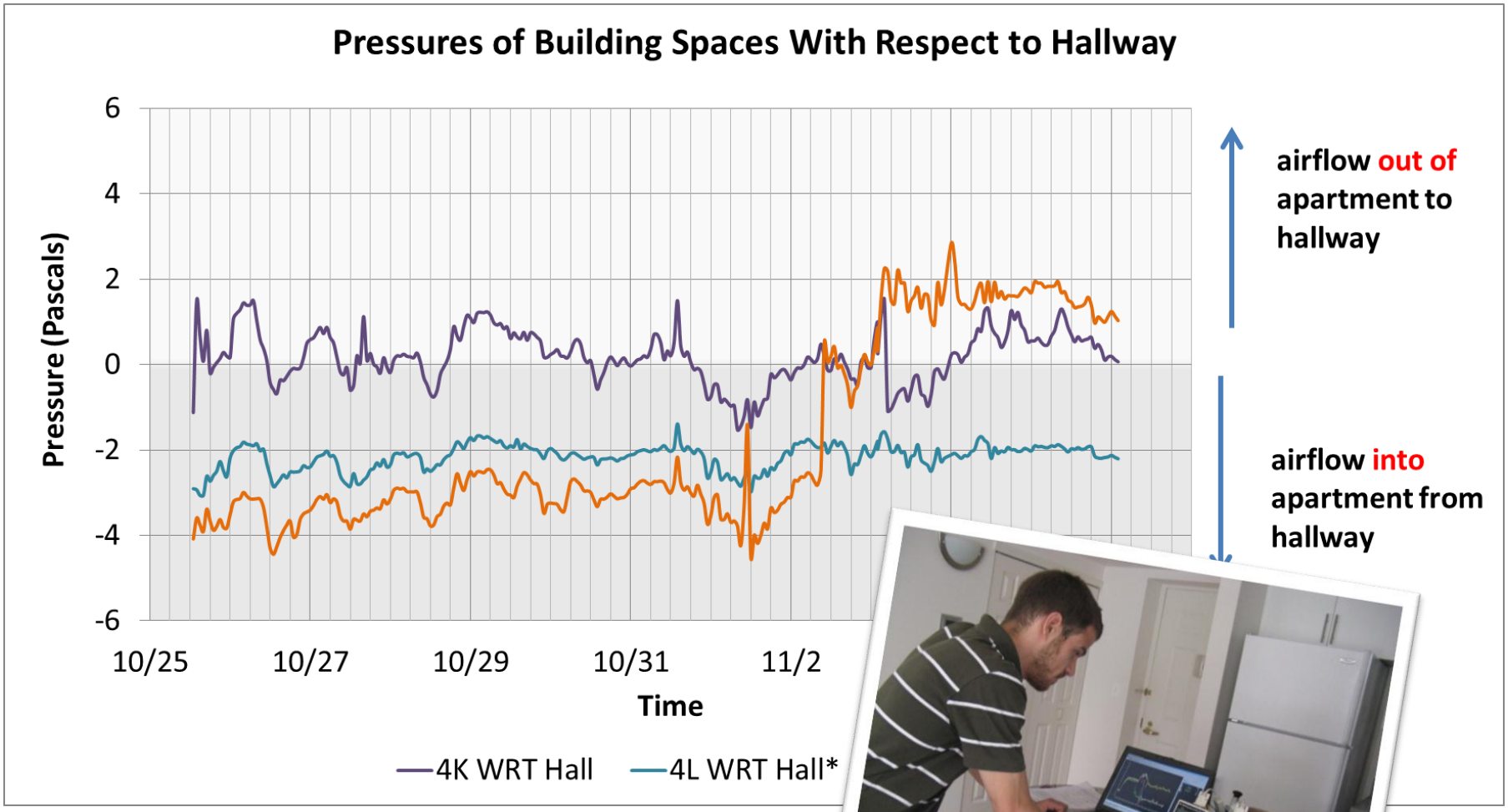
Passive Supply

Balanced

Active Supply



Approach


Pressures of Building Spaces With Respect to Hallway
Pressure (Pascals)
6
4
2
0
-2
-4
-6
10/25
10/27
10/29
10/31
11/2
Time
4K WRT Hall
4L WRT Hall*
airflow out of apartment to hallway
airflow into apartment from hallway

Progress and Accomplishments

Discoveries: Efficiency/ sustainability programs pull a market. People will take the easiest/cheapest route until told they can not. In MPP, more than 50% of the projects in their current pipeline are meeting the outdoor air requirement by using passive vents in the exterior wall.

Accomplishments:

Testing performed in 4 buildings last year

Preliminary findings:

- passive inlet strategies are not reliable (jury still out)
- balanced ducted systems need commissioning
- active supply approach needs further design

Draft report currently being peer reviewed

Project Contribution to Energy Efficiency :

Efficiency programs are important to paving the way for market transformation. To be successful, they need to be credible with specifications that achieve energy efficiency and maintain comfort and indoor air quality. Guidelines from this research will result in more specific ventilation system requirements.

Awards/Recognition: Working with EPA, RESNET, and utilities

Next Steps and Future Plans

- Additional testing of ventilation systems in two more buildings
- Document findings in a Measure Guideline
- Share findings with efficiency program developers/implementers
- Develop and demonstrate aerosol technology method for greater compartmentalization – working with WCEC

Evaluation Criteria

- Relevance to BTO needs and objectives
  - Providing solutions to enable market to move forward
- Approach/Project Management
  - Developing and Demonstrating solutions
  - Disseminating findings to the industry
- Progress, Accomplishments, and Impact(Integration and Collaboration)
  - Reports , case studies, webinars, videos
  - Enabling the Building America Solution Center and DOE Challenge Home Program
  - IECC language addresses specific efficiency measures
  - DOE Challenge Home specifications
  - EPA ESMHR and LEED-H Program specifications
  - RESNET MFWG specifications
  - ASHRAE Std. 62 and 160 revisions
- Next Steps and Future Plans
  - Successfully respond to an upcoming FOA

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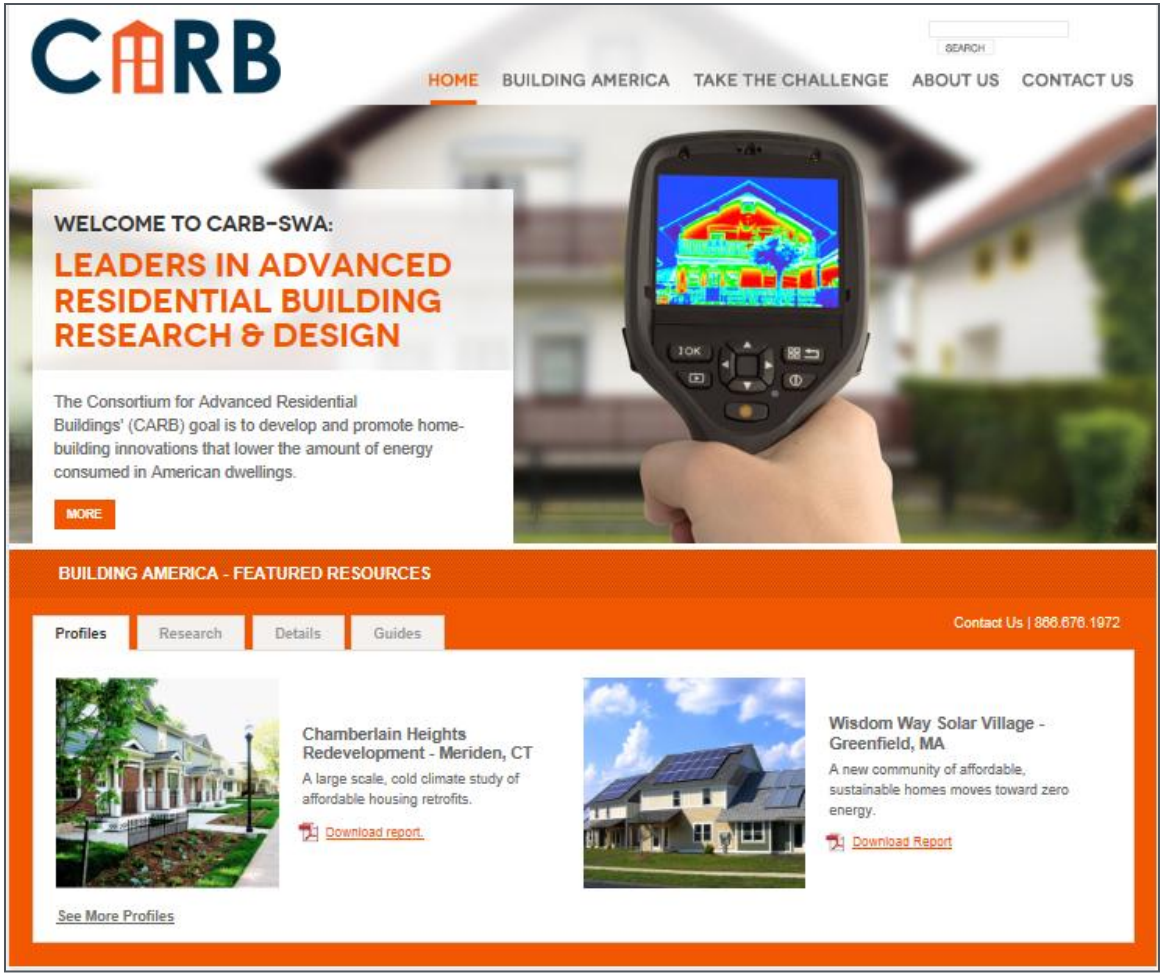
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REFERENCE SLIDES

Project Budget

Project Budget: Building America is a multi-year research program. FY13 and FY14 face-value contract amounts have been summarized here (excluding overhead burden and management).
Variances: Budgets are executed as planned.
Cost to Date: Projects are accrued linearly and managed on a calendar year cycle. For FY14, approximately 30% of project cost has been accrued.
Additional Funding: All BA team contracts have at least 20% cost-share from industry partners.

Budget History					
January 2013 – FY2013 (past)		FY2014 (current)		FY2015 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$7,200k	20%	$8,135k	20%	TBD	TBD

Project Plan and Schedule

Building America Team Project Planning and Execution:

- BA teams are funded under a multi-year Task Ordering Agreement managed by NREL. Project portfolios are selected on an annual basis. 2014 is the final year of this agreement.
- All BA Teams go through rigorous annual project proposal and review process, including review and coordination by NREL technical and DOE program management.
- Each project has the following deliverables: detailed test plan, report, case study and BA Solution Center content. Test plans are reviewed by technical program managers and all other publications undergo a peer review process before being communicated to the broader residential industry.